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National Aeronautics and Space Administration
Washington 25, D. C.

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Status Report 1964 October 1 to 1965 April 1

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1) Mr. John D. Mulholland continues, in his position of Research Associate, with work on his problem of the development of a numerical general perturbation theory for the sixth satellite of Jupiter. Inadequate electronic computer facilities at the University of Cincinnati have markedly impeded his progress during the term of this report. His programming from last year was coded for the IBM-709 (of which none is available in or near Cincinnati). He began recoding for the IBM-7070, but the debugging was not completely successful during the available machine time. Currently, runs are being made on the IBM-709 at Indiana University.

All the available observations of Jupiter VI since its discovery have been collected and reduced to 1950.0, so that they are immediately available for use in determining the constants and parameters of the general theory. There are nearly 500 observations. The orbit improvement program is fully operational, and one complete improvement has been made on the basis of the first order theory. The corrections were so large that the first order theory is now being recomputed, before proceeding further.

2) Dr. Rabe continues his studies of periodic Trojan orbits. Some of the previously computed non-periodic trajectories of Trojan planets in the rotating reference frame of the restricted three body problem exhibited features which suggested the possible

existence of periodic solutions of more complicated shape, combining substantial oscillations of short period with those of the long librational period. To investigate this question, the originally established long-period librations of "simple" shape (Rabe, Astron. J. 66,500; 67,382) were used as intermediate or reference orbits, and the differential equations of motion of superimposed short-period fluctuations (representing the general case of non-periodic overall motion in the sun-Jupiter plane) were integrated, considering all terms up to the third order, or including the third power of the arbitrary oscillation amplitude about the periodic libration. It was found that the characteristic exponent of the superimposed oscillations depends on the arbitrary constants of integration (essentially on the assumed amplitude of the oscillations) in such a manner, that a number of integral values of this exponent exist, for appropriate values of the oscillation amplitude, and that this is true for any basic libration in the range of the actual Trojan planets. These integral values of the characteristic exponent are equivalent with the restoration of periodicity for the resulting overall-trajectory (reference orbit plus superimposed oscillations), the period being identical with that of the basic reference solution. Thus the existence of a great variety of more complicated periodic orbits has been proved by this numerico-analytical method, and these findings became possible again thanks to the availability of the "ordinary" long-period librations as determined in the first stage of this project. The new results have been presented, under the title "A new class of long-period Trojan librations," at the meeting of the American Astronomical Society at Lexington, Kentucky, March 14-17, 1965, and an abstract will appear in the Astronomical Journal. A full report, with a presentation of the method, will be prepared later on, after new present work, employing the same method for a study of the limits of stability of the short-period component (or of the stability with respect to the heliocentric eccentricity of the Trojan's orbit) has been completed. It can be stated already, however,

that the overall librational motion of the Trojans becomes unstable when the eccentricity exceeds surprisingly small limits, and that these new results seem to explain the observed absence of substantial eccentricities among the actual Trojans. The theoretical limit is very close to the actually observed one.

3) During this period Dr. Herget has continued to search for an explanation as to why the planetary perturbation programs for the IBM-1620 will not function properly nor produce satisfactory computational results, but still to no avail. A completely new program, based on Cowell's method, has been coded and fully debugged. The first tests showed that it also had the same inadequacies. But subsequently it has been used successfully on the orbits of several minor planets. This only enhances the quandary.

Work on the IBM-1410 program for computing the orbit of Eros has begun, mainly in the preparation of a magnetic tape of the planetary coordinates. This project will profit considerably from the new Cowell program described above, which has already been completed. The identifications for the final set of observational data for the Leiden-Palomar survey have now been completed, and this work is now ready to proceed to the final computational stages on the NORC.

Respectfully submitted,

Paul Herget, Director

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